ON THE FLAGELLA OF MOTILE BACTERIA.

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(ABSTRACT.)

During the past three years several new methods for demonstrating flagella have been announced. Up to the present, however, a perfectly satisfactory process has not been devised and the results obtained by different workers have been in many instances quite contradictory. The efforts to fix upon the flagella specific characters have also failed, although much advance has been made in that direction.

THE NATURE OF THE FLAGELLA.

Notwithstanding the somewhat definite results which have been obtained in reference to the structure of the flagella, it appears to be of the highest importance that their nature should be more fully determined before they are accepted as constant and integral parts in the morphology of individual bacteria. The examination of a large number of preparations stained by the same method, and frequently a single specimen, will reveal quite different appearances. In some instances, and in my experience on a large majority of the bacilli, the flagella appear as appendages radiating from the body (nucleus according to Bütschli) of the organism. I have occasionally observed a narrow unstained or more feebly-tinted band separating the body of the organism from a deeply-stained ring of which the flaggella appeared to be projections. This capsule-like appearance has been illustrated by several observers. Bütschli, Zettnow and others, hold that the part of the bacillus which is easily brought out by the ordinary staining methods is the nucleus only, and that the additional portion of the organism demonstrated by Lœffler's method is plasma which surrounds the nucleus. Hæckle, on the other hand, states that they have no nuclei. For this and other rea-

phenomena, especially in reference to the free flagella and the formation of the rings and hooks frequently observed both on the distal ends of the flagella, and separated from them, may be explained by the same theories as those of zoospores. There are two views as to the disposition of the flagella of swarm spores. One is, that they are cast off, and the other, that they are absorbed into the body of the spore. Rothert shows, in a recent article, that both views are correct. "In the second swarm stage of saprolegnia and in the peronosporeæ, the flagella are either cast off as soon as the spores come to rest, or soon after, or else they remain attached to the spore indefinitely even after germination. In the first swarm stage of saprolegnia, however, he found, to his surprise, that they are uniformly drawn back into the body of the protoplasm, the withdrawal being slow at first, and then quite rapid. The loops are formed either while the flagella are attached to the spores, or after they are cast off." He suggests the possibility that the flagella are formed out of special cytoplasm existing only in small quantities. It is highly probable from certain opinions and results herein cited, that there is a close resemblance between the flagella of bacteria and those of the swarm spores.

The observations of Stocklin and Bunge that several bacilli are sometimes included within the same capsule from the periphery of which flagella radiate is exceedingly interesting. This phenomenon is explained in two ways, one that the surrounding plasma of two or more bacilli runs together, thus enclosing the bacilli in a common capsule, and the other is that the variable number of bacilli included within the same capsule is due to the multiplication of the organism within the capsule. These observations strengthen the hypothesis that bacteria have nuclei and surrounding plasma.